Journal of Gerontology: MEDICAL SCIENCES
2005, Vol. 60A, No. 9, 1180–1183

Relationship Between Functional Loss Before Hospital Admission and Mortality in Elderly Persons With Medical Illness

Renzo Rozzini,[1] Tony Sabatini,[1] Angela Cassinadri,[1] Stefano Boffelli,[1] Marco Ferri,[1] Piera Barbisoni,[1] Giovanni B. Frisoni,[2] and Marco Trabucchi[1]

[1]Medical Unit for the Acute Care of the Elderly, Poliambulanza Hospital, and Geriatric Research Group, Brescia, Italy.
[2]Laboratory of Epidemiology & Neuroimaging, IRCCS S Giovanni di Dio–FBF, Brescia, Italy, and AfaR–Associazione Fatebenefratelli per la Ricerca, Rome, Italy.

Objective. This hospital-based prospective study tests the hypothesis that, in a large group of hospitalized elderly patients, those who report functional decline between pre-illness baseline and hospital admission have a higher risk of death.

Methods. Nine hundred fifty elderly ambulant patients (F = 69.3%; mean age 78.3 ± 8.5 years) were consecutively admitted to a geriatric ward (Poliambulanza Hospital, Brescia, Italy) during a 15-month period. Number and severity of somatic diseases, Charlson Index score, APACHE II score, level of serum albumin, cognitive status (by Mini-Mental State Examination), and depression score (by Geriatric Depression Scale), were assessed on admission and evaluated as potential prognostic factors. Functional status (by Barthel Index) was assessed by self-report on admission. Preadmission function was also assessed by self-report at the time of admission. Impairment of function due to an acute event is measured as the difference between performances on admission and 2 weeks before the acute event. Six-month survival was the main outcome variable.

Results. Factors related to mortality in bivariate analysis were: male sex, age over 80, cancer, congestive heart failure, pulmonary diseases, elevated Charlson Index score, and (independently) dementia (Mini-Mental State Examination < 18), APACHE–Acute Physiology Score , albumin level <3.5 g/dL, and anemia. After controlling for these variables and for Barthel Index score 2 weeks before the acute event, change in function due to the acute disease is independently related to 6-month mortality (minor functional change [<30 Barthel Index Point] relative risk: 1.3, 95% confidence interval, 0.6–3.0 and major functional change [major functional decrement] relative risk: 2.8, 95% confidence interval, 1.3–5.7).

Conclusions. Disease-induced disability may reflect a condition of biological inability to react to acute diseases (i.e., frailty), and should be assessed as a relevant prognostic indicator.

THE assessment of functional status is the cornerstone of geriatrics. In elderly patients, impairment in functional status is widely considered a strong predictor of poor outcome. Frequently disability—more than diseases—may have a meaningful prognostic value (1–4).

The impact of functional status on prognosis in hospitalized elderly patients has been studied recently. In a hospital general medical setting, Covinsky and colleagues (5) found that activities of daily living (ADLs) contain important information about case mix and prognosis beyond that provided by routine physiologic data and comorbidities; they support the necessity to improve prognostic and case-mix adjustment methods including measures of function as well as routine physiologic measures and comorbidity. Along the same line, Inouye and colleagues (6) demonstrated that functional measures are strong predictors of 90-day and 2-year mortality after hospitalization.

Covinsky and colleagues (7) reported that hospitalized patients' assessment of their ability to perform ADLs before hospitalization have predictive validity of important health outcomes such as functioning and survival, mainly among patients dependent in ADL function on hospital admission. A series of studies has also been done on functional decline in hospitalized elderly patients and on its prognostic value (8,9). In their recent systematic review on predictors of functional decline during hospitalization performed on 27 different studies, McCusker and colleagues (10) included among the most important: worsening cognitive function, delirium, worsening instrumental ADLs, age, living in a nursing home, medical diagnosis, sex, and baseline ADL score. They underlined that, in the hospital, functional decline is a major predictor of negative outcomes in elderly patients (10).

Finally, Fortinsky and colleagues (11) determined how changes in functional status during the 2-week period before hospital admission, and between hospital admission and discharge, influence the risk of nursing home admission in a large cohort of older adults living at home and hospitalized for acute general medical conditions. They found that function on discharge is a key risk factor for nursing home admission (11). All these data describe different functional trajectories in hospitalized elderly persons as a critical clinical indicator giving clinicians a much richer view than the static measures of function.

Because disability is associated with increased risk of mortality, institutionalization, service utilization, and higher societal costs, the study of functional decline is of interest not

only to clinicians, but also to patients and their family members, health services administrators, and health policy makers (12). We would like to contribute to this topic by presenting data on the prognostic impact of functional change on 6-month survival of a large cohort of elderly patients hospitalized for an acute event. In particular, the specific question is whether patients who develop functional decline between pre-illness baseline and hospital admission have higher mortality rates. We suggest that the inability to maintain function after an acute disease has an independent association with mortality. This fact may be due to a loss of homeostatic mechanisms indicating a condition of biological frailty.

Methods

A total of 1320 elderly patients were consecutively admitted for the first time to our Acute Care for the Elderly Medical Unit (ACE-MU) during a 15-month period (February 1998 to April 1999). Admission to the ACE-MU is mainly (82%) through the emergency room.

Because the aim of the study is to evaluate the association of decline in function due to acute disease and mortality, patients in whom functional change could not be assessed as a consequence of floor effect, those patients who were bedridden (i.e., those with a premorbid Barthel Index score ≤ 25) were not included in this study ($n = 122$). Moreover, because functional decline in this study is assumed to represent a condition of multiorgan frailty, patients with major stroke ($n = 155$) (a disease that directly and severely affects disability) were excluded; intensive care unit patients ($n = 10$), patients who died in the hospital ($n = 75$), and those patients lost to follow-up ($n = 8$) were also excluded. Patients entered in the study were 950 (F = 69.3%; mean age 78.3 $\pm$ 8.5 years; minimum age = 60).

Our assessment procedure is that inspired by the model of the ACE-MU as previously published (13). A multidimensional evaluation including information on demographics, cognitive and affective status, physical health, functional abilities, and social support was performed on the first day after admission by a trained staff of geriatricians using a standard protocol. Somatic health was evaluated as single diseases, comorbidity, and physiologic severity.

Single diseases were measured as presence or absence of individual symptomatic diseases uncontrolled by therapy from a list of the 15 most frequent conditions: heart diseases of ischemic or organic pathogenesis, primary arrhythmias, congestive heart failure of pathogenesis other than ischemic or organic, hypertension, stroke, peripheral vascular diseases, diabetes mellitus, anemia, gastrointestinal diseases, hepatobiliary diseases, respiratory diseases, parkinsonism and nonvascular neurologic diseases, musculoskeletal diseases, kidney diseases, and malignancies.

Comorbidity was computed by the Charlson Index (14), which evaluates prognosis based on age and comorbid conditions: With each increased level of the comorbidity index, the cumulative mortality attributable to comorbid disease increases in a stepwise fashion. Physiologic severity was computed by the APACHE II score that, by the Acute Physiology Score, takes into account the degree of abnormality of multiple physiologic variables (body temperature, hypotension, heart rate, respiratory rate, PO_2, pH, sodium, potassium, creatinine, hematocrit, white cell count, Glasgow Coma Score); moreover, the APACHE II score also takes into account age and chronic coexistent conditions (congestive heart failure, chronic obstructive pulmonary disease, cirrhosis, renal failure, and cancer) (15). Number of currently administered drugs was also recorded.

Cognitive status was evaluated by the Mini-Mental State Examination (MMSE) (16), and depressive symptoms with the 15-item Geriatric Depression Scale (GDS) (17). In patients with delirium, the MMSE was administered when the condition had abated. MMSE <18 and GDS >5 indicate poor cognition and mood depression, respectively. The GDS was administered only to patients with MMSE >14.

Self-reported disability in Basic ADLs (BADLs) was assessed with the Barthel Index (18), which measures the independence of a patient in mobility and personal care. It can be used to assess the effect of therapy or to determine the amount of nursing care needed by a patient. A patient scoring 100 on the Barthel Index is continent, feeds himself, dresses himself, gets up out of bed and chairs, bathes himself, walks at least a block, and can ascend and descend stairs.

Disability in Barthel Index was determined by asking patients or their proxy (if patients were unable to give an answer, e.g., demented patients) to recall their premorbid function (15 days before admission) and their present functional status (on admission). Change in function after acute disease was assessed by the difference between Barthel Index score 15 days before and on admission. Disability is detected by the negative change in Barthel Index score. For the aim of the study, functional change was stratified into three group: (1) no change in function after the acute event leading to the hospitalization, (2) a minor change (5–30 points on Barthel Index), and (3) a major change (more than 30 points on Barthel Index).

Six-month mortality as assessed by phone call to relatives was the outcome measure of our analysis. The predictive value of diseases and functional change was assessed versus 6-month mortality, where Kaplan–Meyer curves were used as explorative tools to check for the proportionality of hazards. The unadjusted association of predictors with mortality was estimated with bivariate Cox proportional hazards regression models. The independent association of predictors found to be significantly associated in the bivariate models was assessed in multivariate Cox models where variables were selected in a stepwise fashion with p of the F-to-enter $< .05$ and p of the F-to-exclude $> .10$.

Results

Table 1 shows the sociodemographic, functional, and clinical characteristics of the total study population and after stratification by changes in functional status as detected by differences in Barthel Index score 2 weeks before the acute events and on admission. Data show that severity of somatic, biological, psychic, and functional conditions increases according to the level of functional impairment due to the acute event.

Table 2 shows the crude and adjusted associations of clinical variables and 6-month mortality in the 950 hospitalized

Table 1. Characteristics of 950 Non-Bedridden Hospitalized Elderly Patients According to Decrements in Functional Status as Assessed by Barthel Index 2 Weeks Before and at Admission to Hospital

	Functional Status Deficits			
Characteristic	Total $N = 950$ N (%)/mean ± SD	No Decrements $N = 722$ N (%)/mean ± SD	Minor Decrements (5–30) $N = 133$ N (%)/mean ± SD	Major Decrements (35+) $N = 95$ N (%)/mean ± SD
Sex (female)	658 (69.3)	489 (67.7)	99 (74.4)	70 (73.7)
Age	78.3 ± 8.5	77.2 ± 8.4	80.9 ± 7.6	82.8 ± 7.9
Barthel Index (2 wk before admission)	88.9 ± 15.6	90.6 ± 14.7	85.2 ± 16.7	81.7 ± 17.7
Barthel Index (on admission)	81.6 ± 24.8	90.7 ± 14.7	68.3 ± 20.6	31.3 ± 23.2
MMSE	23.9 ± 6.2	25.0 ± 5.2	21.3 ± 7.1	19.1 ± 8.9
Dementia (MMSE <18)	150 (15.8)	83 (11.5)	30 (22.5)	37 (38.9)
GDS*	5.1 ± 3.6	4.9 ± 3.6	5.8 ± 3.6	5.8 ± 3.8
Depressed (GDS 5+)	417 (51.4)	380 (58.6)	70 (67.3)	38 (64.4)
APS	1.5 ± 2.3	1.2 ± 1.8	2.0 ± 2.8	3.3 ± 4.0
APS (4+)	157 (16.4)	93 (13.0)	27 (20.5)	37 (38.8)
Serum albumin	4.1 ± 0.6	4.2 ± 0.6	3.9 ± 0.5	3.6 ± 0.9
Serum albumin (<3.5 g/dl)	136 (14.3)	80 (11.1)	23 (17.3)	33 (34.7)
Charlson score	6.2 ± 1.8	6.1 ± 1.8	6.5 ± 1.9	7.2 ± 2.0
Charlson score (8+)	168 (17.6)	94 (13.6)	38 (25.5)	35 (32.8)
Anemia	85 (9.0)	42 (6.1)	24 (16.1)	18 (17.2)
Cancer	148 (15.6)	85 (12.3)	35 (23.6)	28 (25.9)
Heart failure (ischemic/organic)	110 (11.6)	78 (11.2)	17 (11.2)	16 (14.7)
Heart failure (extracardiac)	40 (4.2)	19 (2.7)	10 (6.8)	11 (10.3)
Pulmonary disease	197 (20.7)	114 (16.5)	39 (26.1)	44 (40.5)
Chronic renal failure	32 (3.4)	23 (3.3)	3 (1.9)	6 (6.0)
Length of stay	6.7 ± 3.2	6.4 ± 2.7	7.0 ± 3.1	8.3 ± 5.4
6-month mortality	86 (9.1)	43 (6.0)	15 (11.3)	28 (29.5)

Note: *On 811 patients with MMSE > 14 (648, 104, and 59, respectively).

SD = standard deviation; MMSE = Mini-Mental State Examination; GDS = Geriatric Depression Scale; APS = Acute Physiology Score.

elderly patients; variables associated with mortality in bivariate analysis were: male sex, age >80 years, cancer, congestive heart failure (extracardiac), pulmonary diseases, Charlson Index score >4, and, independently, were MMSE <18, APACHE–Acute Physiology Score > 4, serum albumin level < 3.5 g, and anemia (Hb < 10 g/dL). Table 2 also shows that functional change due to acute disease and mortality are significantly associated (the greater the functional decline, the greater the risk of death). This association held even when all the variables significantly associated to 6-month mortality in bivariate analysis and Barthel Index as detected 2 weeks before the hospitalization were controlled for (minor functional change relative risk (RR): 1.3, 95% confidence interval [CI], 0.6–3.0 and major functional change RR : 2.8, 95% CI, 1.3–5.7).

To understand if this association (mortality with different degrees of loss of function after an acute event) could be observed for any level of premorbid function, it was tested in three different groups of patients according to their functional status as detected 2 weeks before the acute events. In the group of well functioning patients (Barthel Index ≥95) before the acute event, the 6-month survival rates were, respectively, 94.5%, 86.3%, and 71.7% (significance at log rank $p < .0001$); in the group of patients with intermediate functional impairment (Barthel Index 65–90), the 6-month survival rates were, respectively, 91.5%, 84.4%, and 78.7% (significance at log rank $p < .05$); and in the patients already disabled before the acute event (Barthel Index ≤60), the 6-month survival rates were, respectively, 88.1%, 66.7%, and 40.0% (significance at log rank $p < .0001$).

Discussion

The results of this study performed in an acute geriatric ward show that the impairment of functional status due to an acute disease has a statistical and clinical prognostic value to be added to the other well known negative prognostic factors (i.e., diseases as well as routine physiologic measures and comorbidity).

In our study, we evaluated the prognostic value of the change in functional status due to an acute disease leading the elderly patient to be hospitalized. In elderly persons, the pathogenic mechanisms of disability are complex and widely studied. We observed than when a disease produces a functional impairment, this condition becomes itself an index of poor outcome, and the strength of the association is dose related (the higher the impairment in function due to the acute disease, the higher the risk). It should be stressed that the association of functional change greater than 30 Barthel Index points with mortality (RR = 2.8) is stronger than that of well established predictors of mortality, such as low serum albumin and anemia (RRs = 2.3 and 2.2, respectively).

On this topic, Covinsky and colleagues (7) suggest that, if a patient presents on admission with functional dependence,

Table 2. Crude and Adjusted Associations of Clinical Variables and 6-Month Mortality in 950 Hospitalized Elderly Patients

Variable	*N*/Events	Unadjusted RR (95% CI)	Adjusted RR (95% CI)
Sex (male)	335/61	1.6 (1.0–2.9)	1.5 (0.9–2.6)
Age (>80)	470/78	1.5 (1.1–2.2)	1.0 (0.9–1.1)
Change in functional status			
No change	670/58	1.0 (reference)	1.0 (reference)
Minor change (5−25)	130/24	1.8 (1.0–4.0)	1.3 (0.6–3.0)
Major change (30+)	148/48	6.2 (3.5–11.5)	2.8 (1.3–5.7)
Mini-Mental State			
Examination (<18)	167/41	3.6 (2.0–6.4)	1.9 (1.1–3.8)
Geriatric Depression Scale (>4)	547/71	1.4 (0.9–2.1)	NS
Acute Physiology Score (>4)	185/57	3.6 (2.1–6.4)	2.3 (1.3–4.3)
Serum albumin (<3.5 g/dl)	177/52	4.5 (2.6–8.0)	2.3 (1.3–4.6)
Charlson Index (8+)	199/75	2.5 (1.3–4.8)	NS
Anemia	97/28	3.4 (1.7–6.6)	2.2 (1.0–5.4)
Cancer	170/66	2.7 (1.8–5.5)	NS
Heart failure (ischemic/organic)	123/24	1.6 (0.8–3.9)	NS
Heart failure (extracardiac)	40/11	2.5 (0.9–7.0)	NS
Pulmonary disease	364/69	1.7 (1.0–3.2)	NS
Chronic renal failure	155/31	2.7 (0.9–8.9)	NS

Notes: Unadjusted: computed in bivariate Cox regression models. Adjusted: computed in a multivariate model where all the variables of the unadjusted analysis were tested for independent association in a stepwise Cox model.

NS = variables failing to reach the threshold for inclusion (see Methods); RR = relative risk; CI = confidence interval.

the immediate prior history of functional independence is a sign of greater functional reserve. These and our data show that the best prognostic status is being independent together with the ability to maintain that independence in the setting of an acute illness. The worst status is chronic dependence, and acute loss is in the middle, demonstrating more reserve than functional dependence.

The issue of functional change, as a marker of clinical stability or instability (homeostasis) in the context of an ill older adult, goes back to the concept of frailty, one that has proved difficult to define (19–21). Most clinicians, and for that matter many of the public, can recognize frail elderly persons when they see them. However, when asked to provide the characteristics that make a particular person frail, they are often at a loss. Despite a huge amount of research, frailty still escapes an operational definition, but some authors have suggested that the loss of homeostasis might be a good indicator of frailty. Furthermore, the inability to remain functionally stable after an acute illness (i.e., the loss of function) might be an evident epiphenomenon of frailty. In this context are of value interventions aimed to maintain, regain, or improve functional performance; they can improve quality of life of elderly persons and reduce health care utilization and risks of admission to a nursing home. A more accurate knowledge of determinants of disability in geriatric practice may be valuable in the identification of the most effective interventions and of the patients most likely to have better outcomes.

Summary

The change in function after an acute disease could be viewed as the mirror of a broader condition of inability to react to stressful events, and for this should be assessed as a relevant prognostic indicator.

ACKNOWLEDGMENT

Address correspondence to Renzo Rozzini, Geriatric Research Group, via Romanino 1, 25122 Brescia, Italy. E-mail: renzo.rozzini@iol.it

REFERENCES

1. Rozzini R, Sabatini T, Trabucchi M. Prediction of 6-month mortality among older hospitalized adults. *JAMA*. 2001;286:1315–1316.
2. Rozzini R, Barbisoni P, Trabucchi M. Functional and biomedical components in the measures of disease severity in the elderly. *J Am Geriatr Soc*. 1995;43:1321.
3. Wu AW, Yasui Y, Alzola C, et al. Predicting functional status outcomes in hospitalized patients aged 80 years and older. *J Am Geriatr Soc*. 2000;48:S6–S15.
4. Gillick MR, Serell NA, Gillick LS. Adverse consequences of hospitalization in the elderly. *Soc Sci Med*. 1982;16:1033–1038.
5. Covinsky KE, Justice AC, Rosenthal GE, et al. Measuring prognosis and case-mix in hospitalized elders: the importance of functional status. *J Gen Intern Med*. 1997;12:203–208.
6. Inouye SK, Peduzzi PN, Robison JT, et al. Importance of functional measures in predicting mortality among older hospitalized patients. *JAMA*. 1998;279:1187–1193.
7. Covinsky KE, Palmer RM, Counsell SR, et al. Functional status before hospitalization in acutely ill older adults: validity and clinical importance of retrospective reports. *J Am Geriatr Soc*. 2000;48:164–169.
8. Sager MA, Rudberg MA, Jalaluddin M, et al. Hospital admission risk profile (HARP). Identifying older patients at risk for functional decline following acute medical illness and hospitalization. *J Am Geriatr Soc*. 1996;44:251–257.
9. Gill TM, Williams CS, Tinetti ME. The combined effects of baseline vulnerability and acute hospital events on the development of functional dependence among community-living older persons. *J Gerontol A Biol Sci Med Sci*. 1999;54:M377–M383.
10. McCusker, Kakuma R, Abrahamowicz M. Predictors of functional decline in hospitalized elderly patients: a systematic review. *J Gerontol Med Sci*. 2002;57A:M569–M577.
11. Fortinsky RH, Covinsky KE, Palmer RM, et al. Effect of functional changes before and during hospitalization on nursing home admission of older adults. *J Gerontol Med Sci*. 1999;54A:M521–M526.
12. Thomas DR. Focus on functional decline in hospitalized older adults. *J Gerontol Med Sci*. 2002;57A:M567–M568.
13. Landefeld CS, Palmer RM, Kresevic DM, et al. A randomized trial of care in a hospital medical unit especially designed to improve the functional outcomes of acutely ill older patients. *N Engl J Med*. 1995; 332:1338–1344.
14. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40:373–383.
15. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. *Crit Care Med*. 1985;13: 818–829.
16. Folstein MF, Folstein S, McHugh PR. Mini-Mental-State: a practical method for grading cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12:189–198.
17. Yesavage JA, Brink TL, Rose TL, et al. Development and validation of a Geriatric Depression Scale. *J Psychiatr Res*. 1983;17:31–49.
18. Mahoney FI, Barthel D. Functional evaluation: the Barthel Index. *Md State Med J*. 1965;14:56–61.
19. Hamernan D. Toward an understanding of frailty. *Ann Intern Med*. 1999;130:945–950.
20. Rozzini R, Frisoni GB, Franzoni S, Trabucchi M. Change in functional status during hospitalization in older adults: a geriatric concept of frailty. *J Am Geriatr Soc*. 2000;48:1024–1025.
21. Covinsky KE, Palmer RM, Fortinsky RH, et al. Loss of independence in Activities of Daily Living in older adults hospitalized with medical illnesses: increased vulnerability with age. *J Am Geriatr Soc*. 2003;51: 451–458.

Received February 2, 2004
Accepted July 29, 2004
Decision Editor: John E. Morley, MB, BCh